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NOTES ON THE HISTORIC RANGE AND NATURAL HISTORY OF *ANAEA TROGLODYTA FLORIDALIS* (NYMPHALIDAE)

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Populations of the Florida leafwing, *Anaea troglodyta floridalis* F. (Comstock & Johnson) (Fig. 1), a butterfly endemic to south Florida and the lower Florida Keys, have become increasingly localized as its pine rockland habitat is lost or altered through anthropogenic activity (Baggett 1982, Hennessey & Habeck 1991, Schwarz et al. 1995, Salvato 1999, 2001). *Croton linearis* Jacq., (Euphorbiaceae) a subtropical species of Antillean origin, is the sole host plant for *A. t. floridalis* (Opler & Krizek 1984, Schwartz 1987, Minno & Emmel 1993, Smith et al. 1994). Once common throughout the pinelands of the lower Florida Keys (Dickson 1955), *C. linearis* now occurs only on Big Pine Key (Monroe Co.) and in fragmented populations on the southeast Florida mainland as far north as Jupiter Island (Martin Co.) (Salvato 1999). However, as host plant availability and appropriate habitat have declined, there is little recent evidence that *A. t. floridalis* ventures further north than southern Miami (Miami-Dade Co.) to make use of these fragmented host populations (Baggett 1982, Smith et al. 1994, Salvato 1999). Salvato (1999) has found few-documented field sighting records or museum collection specimens of *A. t. floridalis* from areas north of Monroe and Miami-Dade counties suggesting that this species may not have been common further north historically.

Delineating the precise historic range of *A. t. floridalis* has been further complicated by its confusion with Florida's other resident *Anaea* species, *Anaea andria* Scudder (Opler & Krizek 1984, Hennessey & Habeck 1991). An extremely tolerant species climatically, *A. andria* is widely distributed in the United States and Mexico (Pyle 1981, Opler & Krizek 1984). In Florida, Hernando County appears to represent the southern boundary for *A. andria* and this may correspond with the distribution of its host plants (Salvato

1999). *Anaea andria* uses several different *Croton* host species throughout its range, as opposed to *A. t. floridalis* which is stenophagic and will only use *Croton linearis* (Opler & Krizek 1984, Schwartz 1987, Hennessey & Habeck 1991, Smith et al. 1994, Worth et al. 1996). In northern Florida, *A. andria* primarily uses *Croton argyranthemus* Michx. (Glassberg et al. 2000) as a host, but will also feed on *C. capitatus* Michx. (Opler & Krizek 1984, Salvato 1999). Salvato (1999), in preliminary feeding studies, found that when offered a variety of *Croton* species (*C. capitatus*, *C. linearis* and *C. argyranthemus*), *A. t. floridalis* larvae ($n = 5$) would only accept *C. linearis* as a food source. *Anaea andria* larvae ($n = 5$), when given the same selection, preferred *C. argyranthemus* as well as *C. capitatus* but refused to feed on *C. linearis*. The preference of *A. andria* for only northern occurring *Croton* species may explain why the butterfly has not established itself farther southward in the state. The apparently strict diet requirements of *A. t. floridalis* and possibly an inability to tolerate the colder winter climate of north Florida keep it from expanding northward. *Croton grandulosus* Michx. is the prevalent *Croton* species in the central part of Florida where neither butterfly occurs. Both *Anaea* species refused this plant as a host when offered it in feeding trials. Salvato is currently conducting continued feeding studies with *A. andria* and *A. t. floridalis* to establish larger sampling sizes. However, it does appear that an allopatric relationship occurs between *A. andria* and *A. t. floridalis* within Florida, one similar to that observed between other members of the genus within the West Indies (Smith et al. 1994). Figure 2 indicates the documented distribution of *A. t. floridalis* and *A. andria* in Florida.

Anaea t. floridalis maintains an appearance characteristic of the genus and the taxonomy of this sub-



FIG. 1. The Florida leafwing, *Anaea troglodyta floridae* 4 January, 2003 in Long Pine Key (Everglades National Park), Florida (photo H. L. Salvato).

species has been well described elsewhere (Comstock 1961, Baggett 1982, Opler & Krizek 1984, Smith et al. 1994, Worth et al. 1996). Briefly, its upperwing surface is red to red-brown, the underside gray, with a tapered outline, cryptically looking like a dead leaf when the butterfly is at rest. *Anaea t. floridae* exhibits sexual dimorphism, with females being slightly larger and with darker coloring along the wing margins than the males (Fig. 3).

The species also appears to demonstrate seasonal polymorphism (Fig. 3). Comstock (1961) employed the terms "summer" and "winter" morph to differentiate between seasonal forms within the genus. Riley

(1980, 1988a, b) found that the length of photoperiod exposure experienced by fifth-instar larvae (several days prior to pupation) as well as the influence of seasonal moisture, were key factors in determining the seasonal forms of *A. andria*. The summer *Anaea* form, (wet-season or long-day form) (late May to September), of the genus tends to have forewing margins which are blunt and a hindwing with a less pronounced tail; their colors also tends to be brighter. The winter *Anaea* form, (dry-season or short day form), (October to early May) tends to have the opposing characters, these being pronounced tails and crescent-shaped forewings.



FIG. 2. Historic distribution of *Anaea* species, by county in Florida. Distribution based on verified records of specimens collected or photographed for each county (J. V. Calhoun pers. com.).

Although a great deal of research has been conducted to explain opposing wing characteristics of seasonal forms and how they are cued (Comstock 1961, Riley 1980, 1988a, b), more research is needed to understand what implications this change in wing shape has on *Anaea* biology. One possibility is that the change in wing shape is an adaptation by *Anaea* to more cryptically blend into its surroundings during given seasons. Muyschondt (1974a, b) indicated that *Anaea* (*Consul*) *fabi* Cramer and *A.* (*Memphis*) *euryptyle confusa* Hall appear very inconspicuous amongst vegetation and that these species alight on

tree trunks in a slanted position to minimize the shadow they project. Similar behavior was observed with *A. t. floralis* while conducting mark-release-recapture field studies from 14 July 1997–29 August 1998. When at rest on the sides of slash pines, *A. t. floralis* adults would angle their bodies, with wings closed, in such a way that it seemed to mimic the raised and peeling bark of the pine trees.

Anaea t. floralis caught during the winter/spring months (October to early May) of the 1997–98 study ($n = 46$), always maintained well-developed hindwing tails and anal angle projections, as well as forewings



FIG. 3. Demonstration of seasonal and sexual dimorphism in *Anaea t. floridalis*. Males (on the left), females (right). Butterflies on the top row are the winter-morph, those on the bottom, the summer-morphs (photo M. H. Salvato).

with an acute and falcate apex. Likewise, those marked in the summer/fall months (late May to September) ($n = 85$), possessed shortened tails on the hindwing, reduced anal angle projections, and forewings that were not apically falcate. Several larvae ($n = 15$) were reared from field-collected specimens in the winter months (January–March) of 1999. These all produced the winter form. Table 1 indicates the seasonal forms observed in the field-marked *A. t. floridalis* in 1997–98. Further field studies are required to determine the precise periods of change from winter to summer-morph (and from summer to winter-morph). An abrupt change from winter to summer-morph indicated in field-captured specimens in April and May 1998 suggests that this is the period of change to the summer-morph for *A. t. floridalis*. There was no evidence of intermediate forms between the seasonal morph types. Field-marked adults and museum examined specimens showed characters that were distinctly one of the two-morph patterns. Whether the bi-annual change in wing shape is an adaptive response that produces appropriate seasonal camouflage and/or aerodynamic advantages to flight remains an interesting topic for future study and discussion.

Behavior and life cycle observations documented during this study are consistent with what has been re-

ported previously for this subspecies (Baggett 1982, Opler & Krizek 1984, Schwartz 1987, Smith et al. 1994, Worth et al. 1996). The adults are rapid, wary fliers. The species is extremely territorial, with both sexes flying out to pursue other butterflies (Baggett 1982, Worth et al. 1996). The occurrence of adults consistently perching on the same spot, on a tree or sign post, as well as using the same specific host specimen for oviposition, suggests these areas are continually suitable and recognized. This behavior was partic-

TABLE 1. Monthly overview of seasonal wing patterns observed in marked and released *Anaea troglodyta floridalis* between 14 July 1997 and 29 August 1998 on Big Pine Key and Long Pine Key, Florida.

Month	n	Winter-morph	Summer-morph
January	11	11	0
February	7	7	0
March	2	2	0
April	14	14	0
May	12	2	10
June	18	0	18
July	17	0	17
August	29	0	29
September	2	0	2
October	2	0	2
November	17	10	7
December	0	0	0

ularly well observed (8 occurrences on different survey dates) in the Watson's Hammock area of Big Pine Key during 1997–98. *Anaea t. floricidalis* is multivoltine, with an entire life cycle of about 60 days (Hennessey & Habeck 1991), and maintains continuous broods in south Florida throughout the year (Salvato 1999). Precise number of broods per year remains unknown, but *A. t. floricidalis* has been recorded in every month (Baggett 1982, Opler & Krizek 1984, Minno & Emmel 1993, Salvato 1999) in south Florida. Males, especially those newly emerged, were frequently flushed from their perches in response to a fluorescent-colored cloth, either by waving it the air or simply placing it in a shirt pocket (Salvato 1999, Salvato 2003). Females lay eggs singly on both the upper and lower surface of the host leaves, normally on developing terminals (Baggett 1982, Hennessey & Habeck 1991, Worth et al. 1996, Salvato 1999). Eggs are spherical and light cream-yellow in color (Worth et al. 1996). Worth et al. (1996) and Salvato (1999) visually estimated that females may fly more than 30 meters in search of a suitable host and usually requires less than a minute to oviposit each egg.

During egg surveys conducted in 1988–89 in both Everglades National Park and Big Pine Key, egg density was approximately 11–66 per ha on sparse patches of host plants scattered throughout the pine rocklands (based on an estimated 80 ha of *Croton*-bearing habitat on Big Pine and 1068 ha in the Everglades) (Hennessey & Habeck 1991). Eggs of many Neotropical charaxine species similar to *Anaea*, such as *Memphis* Hubner and *Consul* Hubner are heavily parasitized by chalcid wasps (Muyshondt 1974a, b, 1975a, b, 1976a, b, DeVries 1987). Within the pine rocklands *A. t. floricidalis* eggs experience a high level of parasitism from trichogrammid wasps (Hymenoptera: Trichogrammatidae). Once attacked by the wasps, the *Anaea* eggs turn black (Muyshondt 1975b, Hennessey & Habeck 1991, Salvato 1999). The frequency of these “black eggs” was noted to be as high as 100% in 1988–89 surveys for *A. t. floricidalis* eggs on host terminals both in the Everglades National Park and at Watson's Hammock on Big Pine Key (Hennessey & Habeck 1991). *Trichogramma* sp. near *pretiosum* Riley “Naranja species” was identified as the parasitoid and appears to be a key mortality factor for *A. t. floricidalis* (Hennessey & Habeck 1991, Salvato 1999). Hennessey & Habeck (1991) found the larval hatch rate in the field for all survey areas during their 1988–89 studies, including all mortality sources, ranged from 0–33%, depending on location and year. On two occasions (6 July 1988 and 10 October 1989) the mite *Balaustium* sp. (Acari: Erythraeidae) was observed preying upon eggs of *A. t. floricidalis* within the

Everglades (Hennessey & Habeck 1991). Crab spiders (Aranea: Thomisidae) were frequently observed in 1988–89 and 1997–98 surveys on *C. linearis* and may prey upon eggs of *A. t. floricidalis* as well as the Bartram's hairstreak, *Strymon acis bartrami* Comstock and Huntington (Lycaenidae). Matteson (1930) recorded ants as predators of *A. t. floricidalis* eggs in Miami.

Because the host is dioecious, sex of the plant was noted when eggs were marked (by placing flagging tape on the plant) in order to determine whether there was an oviposition preference by the females (Hennessey & Habeck 1991). Of 31 plants recorded with eggs between 10 March and 5 July 1989, 14 (45%) were male plants and 17 (55%) were female plants. Female *A. t. floricidalis* showed little preference for female over male plants as oviposition sites (Hennessey & Habeck 1991). However, further studies are required to determine if there is any preference for host plant sex in *A. t. floricidalis* oviposition behavior.

The natural history of the larval stages of *A. t. floricidalis* is well described elsewhere (Baggett 1982, Opler & Krizek 1984, Schwartz 1987, Smith et al. 1994, Worth et al. 1996, Salvato in press). Unlike other members of *Anaea* and similar genus such as *Memphis* (Muyshondt 1974b, 1975a, b, DeVries 1987) and *Consul* (Muyshondt 1974a, DeVries 1987), larvae of *A. t. floricidalis* do not make frass chains or roll plant leaves into tubes to evade parasites and predators. Caldas (1996) found fifth instar larval parasitism by tachinid flies to be as high as 53% for *Anaea* (*Memphis*) *ryphea* Cramer. Muyshondt (1974b) estimated larval mortality from tachinid flies to be 40% for *A. (M.) e. confusa*. Tachinid flies were noted as a principle mortality factor for *A. (C.) fabius* (Muyshondt 1974a). DeVries (1987) indicated that larvae of *Anaea aidea* (Guerin-Meneville) experience parasitism from tachinid flies as well as chalcid wasps. Tachinid flies appear to be a parasitoid on the larval stages of *A. t. floricidalis*, laying their eggs on the host plant, which are subsequently ingested. Hennessey & Habeck (1991) collected a moribund fifth-instar *A. t. floricidalis* larva at Long Pine Key (Everglades) on 14 November 1988. The specimen was host to four larvae of *Chetogena* sp. (Diptera: Tachinidae) that emerged from it in the laboratory; these larvae pupated and became adults. Muyshondt (1975b) obtained a large tachinid species (*Archytas* sp.) from the pupa of *Anaea* (*Memphis*) *pithyusa* R. Felder. Hennessey & Habeck (1991) encountered an *A. t. floricidalis* pupa on Big Pine Key that was in the process of being consumed by ants (species not specified). Muyshondt (1975a) suspected heavy predation on larvae of *Anaea* (*Memphis*) *morvus boisduvali* Comstock from spiders after witnessing spiders in the

proximity of leaves where larvae had been feeding. Spiders appear to be a predator on the adult *A. t. floridalis* as indicated from a photograph in Glassberg et al. (2000) of a lynx spider (Aranea: Oxyopidae) with a captured adult. However, Rutkowski (1971) watched a spider (species not specified) quickly release an adult *A. t. floridalis* from its web after an initial taste. This suggests *A. t. floridalis* may be chemically protected from certain predatory species.

Adults are not frequently attracted to flowers (Baggett 1982, Opler & Krizek 1984, Worth et al. 1996) but have been observed feeding on rotting fruit and dung (Baggett 1982, Opler & Krizek 1984, Minno & Emmel 1993). DeVries (1987) reported that both sexes of *A. aidea* feed on rotting fruits and dung, while males would engage in puddling. Hennessey & Habeck (1991) observed an adult feeding at senescent flowers of saw palmetto, *Serenoa repens* Bartr. alongside scarab beetles (Coleoptera: Scarabaeidae) in Watson's Hammock during 1988. A sliced orange placed at one of the survey transects in the early evening provided the only observation (August 1998) of feeding by adults during 1997–98 field studies (Salvato 1999). Although the species is known to be easily captured in bait traps (Smith et al. 1994), such traps set out at several locations failed to attract any *A. t. floridalis* during the 1997–98 field study. Lenczewski (1980) observed *A. t. floridalis* (sexes not specified) at the edges of mud puddles in the Everglades. Puddling behavior was also observed on 6 occasions during 1997–98, by males on Big Pine Key and in the Everglades. Adults reared and kept in captivity also did not feed on provided flowering plants, but frequently fed on artificial sources provided (especially beer).

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EDITH'S COPPER, *LYCAENA EDITHA* (LYCAENIDAE), CONFIRMED FOR CANADA

Additional key words: Thomas Baird, Alberta.

The status of Edith's Copper, *Lycaena editha* (Mead), in Canada has been a matter of conjecture for some time, particularly in Alberta. Bowman (1934, 1951) included this species in his annotated lists of Alberta Lepidoptera, giving High River as the locality without further comment. This represented the only known Canadian record of Edith's Copper; its known range is restricted to the western US, from California to Montana eastward to Wyoming and Colorado (Scott 1986). Subsequent works (e.g., Ferris & Brown 1981, Scott 1986) also indicated this species as part of the Alberta fauna, presumably based on Bowman's list. Bird et al. (1995) were unable to authenticate this record and rejected it. Layberry et al. (1998) also treated this as a dubious record, and did not include *L. editha* as part of the Canadian fauna.

While curating the butterflies in the University of Alberta Strickland Museum collection in 2001, BCS discovered the putative High River specimen in a separate teaching collection, where it had gone unnoticed these many years. It is a male specimen, missing the left antenna but otherwise in excellent condition, with a label reading "High River, Alta / Baird" (Fig. 1). "High River" and "Baird" are handwritten on a printed Donald Mackie label, and "Edmonton" and "D. Mackie" are crossed out (Fig. 1). Comparison of the handwriting to other Donald Mackie labels shows that the specimen was labelled and likely pinned by Mackie after he received the unpinned specimen from Baird. A small amount of glue is visible on the ventral thorax and on the pin, further suggesting that the specimen

was not pinned fresh. Donald Mackie made extensive Lepidoptera collections, primarily from the Edmonton region, in the early to mid-1920's, and the specimen was likely either sent or given to him by Baird. Thomas Baird came to High River from Woodstock, Ontario in about 1896, and worked there for many years as a cobbler. He was an ardent and versatile collector of all groups of insects, though he appears to have been particularly partial to Diptera. F. H. W. Dod, in his series of "Further notes on Alberta Lepidoptera" (Dod 1914, 1915a, b) made frequent reference to Baird's collections. Among the moths that Baird collected, especially at light, were a number of taxa that were new to science.

The precise location where the High River specimen was collected is impossible to determine, but there is no reason to believe it was not collected in the general vicinity of the town of High River (50°35'N, 113°52'W). Suitable Canadian Zone valley bottom wet meadow habitat that *L. editha* is reported to frequent (Scott 1986) occurs in the Rocky Mountain foothills west of High River, and it is entirely possible that the specimen originated there. Other butterfly species collected by Baird and labeled as "High River" are restricted to montane habitats rather than the prairie habitat found at High River, suggesting Baird named his collection localities to the nearest major settlement, as did many early collectors.

Although it is possible that this specimen is mislabeled, there is no evidence to suggest this. Furthermore, there are no accounts of, or insect specimens